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The perceptual and acoustic characteristics of Korean idiomatic and literal sentences

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Previous studies have suggested that formulaic and literal expressions are stored and processed according to differing characteristics, and that certain auditory–acoustic cues serve to distinguish formulaic from literal meanings. This study took these observations a step further by investigating listeners' ability to discriminate between literal or idiomatic exemplars of ambiguous utterances and determining the acoustic features underlying this distinction in a non-Indo-European language. 'Ditropically ambiguous' sentences, those with either a plausible literal or an idiomatic meaning, were audio-recorded by native speakers of Korean, once with an intended literal and once with an idiomatic meaning. Native Korean listeners were highly successful in discriminating the intended idiomatic or literal meanings. Acoustic analysis revealed that idiomatic utterances were characterized by significantly greater mean intensity, intensity variation, shorter duration, and greater variation in syllable duration; these cues differ from those shown to differentiate American English and French ditropic sentences. The findings suggest that acoustic cues serving to consistently distinguish the two utterance types, although different for different languages, may have universal status.

Keywords: Ditropic sentences, Idiomatic meaning, Literal meaning, Listening study, Acoustic analysis, Korean

Introduction

Understanding a language and producing speech involve processing not only of newly created, grammatical utterances, but also formulaic expressions (Altenberg, 1998; Bolinger, 1977; Sinclair, 1987; Wood, 2010). While the grammar of human language is configured to generate a potentially infinite set of sentences through grammatical rules operating on morphemes and lexical items, such that each sentence is theoretically newly created or newly heard (Pinker, 1994), another component of human verbal communication is made up of unitary, fixed expressions that are known to the native speaker. Formulaic language includes speech formulas (e.g., greetings), expletives, pause fillers (e.g., 'well', 'you know'), serials (e.g., counting, days of the week), memorized text (e.g., the Pledge of Allegiance), song lyrics, proverbs, and idioms (Van Lancker, 1987; Wray and Perkins, 2000), which are part of native language competence (Fillmore, 1979; Pawley and Syder, 1983; Van Lancker Sidtis and Rallon, 2004). These two types of expressions have different properties. Unlike newly created, novel expressions, formulaic expressions have stereotyped form, conventionalized meaning, socially and culturally associated contingencies, and familiarity recognition by native speakers (Kuiper, 2009; Van Lancker Sidtis, 2004, 2010). Formulaic language has been characterized by its stereotyped form including prosodic properties, such as canonical intonation contour and distinctive voice quality (Van Lancker Sidtis, 2008) (The proposal that idiomatic utterances have stereotyped prosodic contours has been challenged (Ashby, 2006; Mackay and Ashby, 2006), saying, rather, that differences in focus (accent marking) signal the literal version.). It was noted some time ago that articulatory and resultant perceptual characteristics of these two types of expressions differ from each other (Lieberman, 1963).

An idiom, a classic example of formulaic language, is a string of words for which the meaning is not simply derivable from the meanings of the individual words comprising that string (Katz, 1973; Nunberg

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et al., 1994). Further, some idioms are 'ditropically ambiguous' (Abdelli-Beruh *et al.*, 2007; Bélanger *et al.*, 2009; Van Lancker and Canter, 1981; Van Lancker *et al.*, 1981; Van Lancker Sidtis, 2003). These sentences can have either an idiomatic or a plausible literal meaning, such as 'David spilled the beans,' which, in addition to the obvious literal meaning, carries the possibility of the nonliteral meaning that David revealed a secret in an untimely manner. Such sentences provide the ideal material for studying the characteristics of idiomatic and literal utterances. The term *ditropic* is used in this paper to refer to sentences that can have both plausible literal and idiomatic interpretations.

Psycholinguistic studies have shown a difference in the ways formulaic expressions are processed compared to newly created, novel expressions. Numerous studies of comprehension have been performed. Memory tasks were used as measures to demonstrate differences between subjects' responses to idiomatic versus nonidiomatic expressions (Horowitz and Manelis, 1973; Osgood and Hoosain, 1974). Subjects were better able to remember the individual words of the nonidiomatic phrases. Swinney and Cutler (1979) showed differences in recognition of formulaic expressions as compared to matched literal (grammatical) (For the purposes of this study, 'novel,' 'grammatical,' and 'literal' are used interchangeably to refer to newly created expressions, in contrast to fixed and overlearned expressions, here called 'formulaic.') expressions, utilizing reaction-time measures in a noun-phrase identification task. Reaction times were shorter for idiomatic expressions than for literal expressions. More recent work (Gibbs and Gonzales, 1985; Tabossi *et al.*, 2008, 2009) also reported that idiomatic expressions were recognized faster than their matched literal controls. For reading, studies using various research designs have reported faster reading times for formulaic expressions compared to matched control strings (Conklin and Schmitt, 2008; Katz and Ferretti, 2001; Siyanova-Chanturia *et al.*, 2011; Turner and Katz, 1997; Underwood *et al.*, 2004). These and related studies lead to the proposal that formulaic expressions are processed holistically as a coherent unit, in that the whole is greater than the sum of the parts (Erman and Warren, 2000; Lin, 2010; Lounsbury, 1963; Sinclair, 1991).

Van Lancker and Canter (1981) reported experiments on the perception of American English ditropic sentences. Listeners correctly identified sentences as either literal or idiomatic correctly at a level well above chance from the acoustic signal alone, in the absence of any situationally or linguistically disambiguating context. Later studies reported that native listeners performed significantly better than non-native listeners regardless of the amount of linguistic training non-native listeners received (Van Lancker Sidtis, 2003). These findings support the notion that the ability to discriminate subtle prosodic contrasts is an inherent component of native listeners' knowledge. Converging evidence suggests that formulaic expressions are acquired and used as emergent units with stereotyped lexical configuration and prosody, which includes the property of holistic coherence, according to studies in neurophysiology (Cappelle *et al.*, 2010) and psycholinguistics (Libben and Titone, 2008).

Acoustic cues that might enable such a high degree of discriminability, and that lead to performance differences in listening tasks, were first analyzed by Van Lancker *et al.* (1981). Literal utterances were significantly longer than idiomatic utterances, and they were characterized by a greater number of word accents and pauses than idiomatic utterances. Content words (nouns and verbs) were longer in duration in the literal counterparts. Systematic differences in vocal quality were also reported. Prosodic cues in the production of literal and idiomatic sentences by native speakers of English were also investigated in terms of durations and fundamental frequency by Bélanger *et al.* (2009). As in the previous study, idiomatic utterances differed systematically from literal counterparts in terms of acoustic measures. The studies reviewed above were performed on American English samples. Second language speakers were not able to utilize acoustic cues to differentiate the sentence type. These observations lead to questions about other languages. Do other languages manifest a systematic auditory–acoustic contrast in the members of the ditropic pairs? If so, what acoustic cues are utilized? Are they the same or different or present in different contrastive relationships from these found in American English?

Abdelli-Beruh *et al.* (2007) compared use of acoustic–phonetic cues differentiating idiomatic from literal expression of ditropic sentences in American English and Parisian French. Acoustic–phonetic cues were differently utilized to differentiate between literal and idiomatic utterances in these two languages. In English, literal utterances demonstrated longer durations and more variations in fundamental frequencies than idiomatic utterances, whereas in the study of French idiom–literal pairs, longer durations and more variations in fundamental frequencies were observed in idiomatic utterances. English speakers utilized an abrupt fundamental frequency change between penultimate and ultimate syllables in idiomatic utterances, while the abrupt fundamental frequency change between last two words was observed in literal utterances in French. Further studies of how ditropic sentences are perceived and conveyed in different languages, especially in a language that is

highly distinct from English, would contribute to understanding the use of acoustic cues in speech perception.

Korean is appropriate to study for this purpose as Korean prosodic patterns differ in interesting ways from those of English or French. Korean does not have lexical level prosody, whereas English and French do (Shin and Speer, 2012). Korean is unlike English in that it is not a stress language. Since Korean does not have stress, duration and intensity changes are less likely to be associated with changes in local prominence. The intonational structures of English and Korean differ in several respects. The *F*0 contour of an English intonation phrase is determined by pitch accents, while in Korean, particular tonal shapes are associated with boundary tones that are used to demark intonation phrases (Jun, 1996, 1998, 2005).

This study was designed, first, to replicate and extend previous findings that native listeners are able to distinguish idiomatic from literal utterances using prosodic cues alone, and to do so in a non-Indo-European language, Korean. One major goal of this current study was to examine the universality of this element of linguistic competence by extending the inquiry into a non-Indo-European language. Korean may be a language isolate or it may be related to the Altaic family of languages. The second goal was to further explore acoustic cues that may be contrastive for literal and idiomatic utterances. It was predicted that native listeners of Korean will successfully distinguish idiomatic from literal meanings of ditropic sentences from the auditory stimulus alone. If listeners are successful, subsequent analysis was intended to discover the key temporal and spectral cues that could distinguish between the utterances.

Experiment I: perception study

The purpose of the listening study was to explore the abilities of native listeners to distinguish idiomatic from literal utterances using auditory/acoustic cues. This was done by having listeners identify the utterances, presented in random order, as idiomatic or literal. In a second task (goodness ratings), stimuli were identified to listeners as to category (literal or idiomatic), and listeners rated how well each exemplar represented that category. The relationship between identification and goodness ratings of the intended meaning of each utterance was also examined.

Method

Participants/listeners

In accordance with Institutional Review Board (IRB) guidelines and approval, demographic information was collected from 15 native listeners of Korean (6 males and 9 females), who currently reside in South Korea, ranging in age from 25 to 34. Informed consent was obtained for each participant. All participants were born and educated in South Korea and ranged in education from 12 to 18 years. They reported normal or corrected-to-normal visual acuity and had no history of previous speech/language disorders or any significant medical or neurological conditions.

Stimuli

Ten ditropically ambiguous Korean sentences were used for this study (see Appendix 1). The sentences were selected from a larger set of idioms based on informal familiarity ratings by a cohort similar in age and education to the listeners. The idioms selected to all have plausible literal meanings. The initial carrier phrase elements (i.e., 'he' or a male proper name common in Korean) were selected so as not to bias a literal or idiomatic interpretation through choice of lexical item. Four native speakers of Korean (2 males and 2 females), educated and currently residing in Korea, produced each sentence twice with either an idiomatic or literal meaning.

The mean age of the speakers was 28 years of age (range: 25–33 years) and mean years of education was 19.8 years (range: 18–23 years). Each sentence was produced with a grammatical subject in the sentence to increase the naturalness of the utterances. Grammatical subjects were placed in the beginning of each sentence. For example, an idiom, '/pɔltʃipɨlkɔdɨrjɔs'ɔ/ (stirred up a bee hive; 벌집을건드렸어)' was produced with a grammatical subject '/kɨsaramɨ/ (he; 그사람이).' Four of the stimuli used a proper noun as carrier phrase element and six used a pronoun. For expression 6, for example, the two meanings are 'Yoonho had a stomach ache,' or 'Yoonho was jealous.' A uniquely identified person (although fictional) could equally well be described with both these conditions. For these sentences, use of pronoun or proper noun introducing the stimulus was not judged to affect the plausibility of either the literal or idiomatic intended meaning. The target sentences were recorded using a Dell Inspiron 6000 laptop via Rocketfish digital microphone (Model RF-USAMIC). The recordings were conducted in a quiet room with a microphone-to-mouth distance of 15 cm.

Speakers saw cards written with target sentences and intended interpretations labeled as either 'idiomatic' or 'literal,' and were asked to mentally picture the meaning of each sentence and to convey the intended meaning while producing the utterance as naturally as possible. The speakers did not have any training relevant to the research question. Other linguistic and psycholinguistic studies that focused on prosodic components in certain speech types have successfully used this induction method to elicit target

sentences (Barkhuysen *et al.*, 2010; Grichkovtsova, Morel and Lacheret, 2012; Murray and Arnott, 2008; Van Lancker and Canter, 1981). For each sentence, a card with the idiomatic meaning was provided first and then a card with the literal meaning was shown. Sentences were presented in the order given in Appendix 1. Participants produced each sentence twice in succession. A total of 160 utterances recorded by native speakers of Korean were utilized as stimuli.

Procedure

The listening tasks were modeled after Van Lancker and Canter (1981), with an additional measure (see Goodness Rating), and the experiment was designed and implemented using PRAAT version 4.5.25 (Boersma and Weenink, 2007). Stimuli were presented in a quiet room over closed headphones.

A total of 160 stimuli were used for three tasks for listeners: two versions of the identification task and the goodness rating task. Identification tasks were formatted as a randomized single sentence task (160 sentences, 40 sentences from each of the four speakers' productions) and a contrastive pair task (80 pairs, 20 pairs for each speaker's productions). The randomized single sentence task was utilized to evaluate the listeners' abilities to discriminate between idiomatic and literal expressions from the singleton auditory stimulus alone. Participants were given two choices on the screen, *idiomatic* and *literal*, and instructed to click one of the virtual buttons after they listened to each utterance. Responses were scored correct or incorrect for each utterance. For the contrastive pair task, two utterances representing the same sentence type were presented in succession, one with an idiomatic meaning and the other one with a literal meaning. The order of literal–idiomatic or idiomatic–literal was randomized across pairs. On the computer screen, participants were given two choices, *idiomatic–literal* and *literal–idiomatic*, and instructed to click one of these two buttons. Responses were scored correct or incorrect for each utterance.

The goodness rating task (160 sentences, 40 sentences for each speaker's productions) followed the identification tasks. For the rating task, participants were informed, for each utterance, whether an idiomatic or a literal meaning was intended. On presentation of the stimulus item and its correct category, participants rated the spoken utterance on a scale of 1–5, with 5 being a very good example (of an idiomatic or a literal utterance) and 1 being a very poor example.

All participants performed the three tasks in the same order: first, a randomized single sentence task, second, a contrastive pair task, and third, the goodness rating task. The listening session for each participant lasted approximately 1 hour.

Results

Participants identified the intended meanings of ditropic sentences with 70.65% accuracy (SD = 16.98) in the randomized single sentence task and with 75.67% accuracy (SD = 20.9) in the contrastive pair task. Binomial tests revealed that listeners identified sentence meanings (either a literal or an idiomatic meaning) correctly at a level above chance in each task ($P < 0.001$ for both tasks). Although there was a tendency for the listeners to be more accurate when they listened to contrastive pairs rather than single sentences, the difference was not significant. These results indicated that native listeners of Korean were able to successfully identify the intended meanings (idiomatic or literal) of Korean ditropic sentences, whether the stimuli were presented in single or in pairs (Fig. 1).

As seen in Figs. 2 and 3, the results from the randomized single sentence tasks were further analyzed by examining the performance of listeners on utterances made by each individual speaker. Measures of

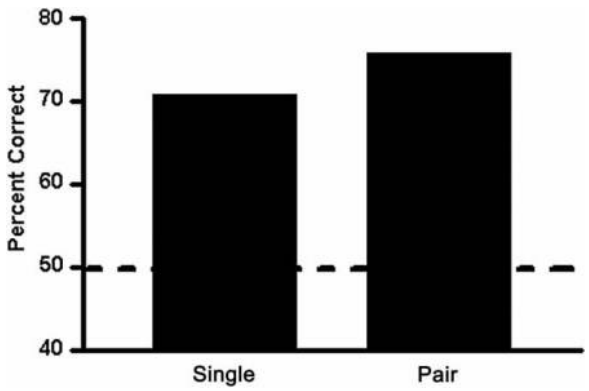

Figure 1 Identification of idiomatic and literal meanings in the randomized single sentence task and in the contrastive pair task. The dotted line represents chance responses.

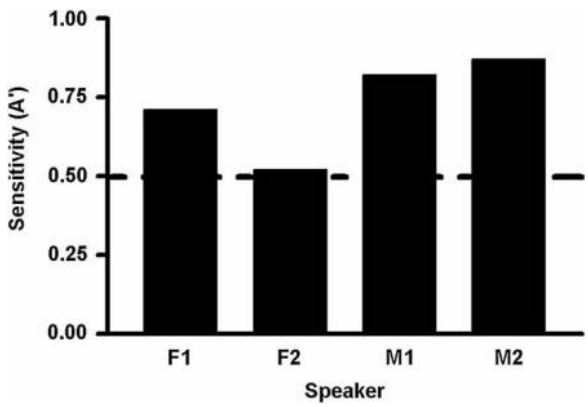

Figure 2 Sensitivity (*A*′) for single utterances produced by each speaker. Listeners showed poor sensitivity on utterances produced by one of the female speakers (*F2*) compared to those by other speakers (*F1*, *M1*, and *M2*). $A' = 0.5 + [\{(PFA - PHIT)\cdot(1 + PFA - PHIT)\}/4\cdot PFA\cdot(1 - PHIT)]$, (PHIT: the proportion of hits; PFA: the proportion of false alarms). The dashed line indicates chance response.

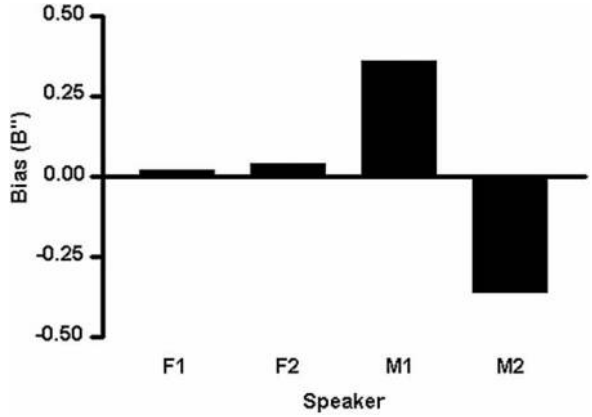

Figure 3 Response bias (B'') for single utterances produced by each speaker. There was no clear trend for all speakers with respect to the response type (idiomatic vs. literal) except for male 1. $B'' = [\{(1 - PHIT)\cdot(1 - PFA)\} - (PHIT\cdot PFA)]/[\{(1 - PHIT)\cdot(1 - PFA)\} + (PHIT\cdot PFA)]$, (PHIT: the proportion of hits; PFA: the proportion of false alarms).

sensitivity (A') (Fig. 2) revealed that listeners exhibited poor sensitivity on utterances produced by one of the female speakers (female 2) compared to those by other speakers (female 1, male 1, and male 2). Repeated measures ANOVA and post hoc paired samples *t*-test confirmed that there is a significant difference in sensitivity between utterances produced by female 2 and those produced by other speakers [$F(1, 14) = 32.270$, $P < 0.001$]. It was also revealed that listeners showed significantly higher sensitivity for utterances produced by male speakers compared to utterances produced by female 1 ($F1$) ($P < 0.001$). One-sample *t*-tests confirmed that listeners correctly recognized sentence meanings (either a literal or an idiomatic meaning) of utterances produced by all speakers except for female 2 at a level above chance ($P < 0.001$ for female 1, male 1, male 2).

Response bias (B'') (Fig. 3) and one-sample *t*-tests showed that there was no clear trend for all speakers with respect to the response type (idiomatic vs. literal) except for male 1. There was a significantly strong response bias for the idiomatic response on utterances produced by male 1. There was a response bias for the literal response on utterances produced by male 2, which, however, was not significant.

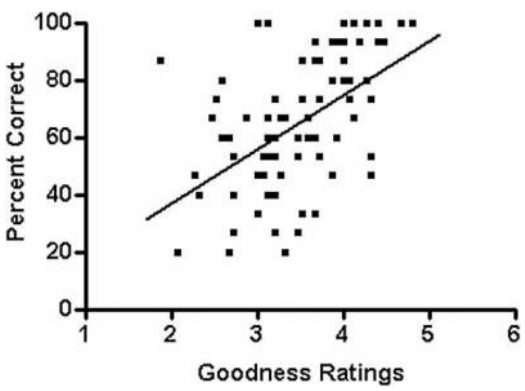

Figure 4 Scatter plot showing the relationship between the percentage of correct responses and the goodness ratings on idiomatic utterances. A significant correlation between ratings on utterances and the correct responses was found.

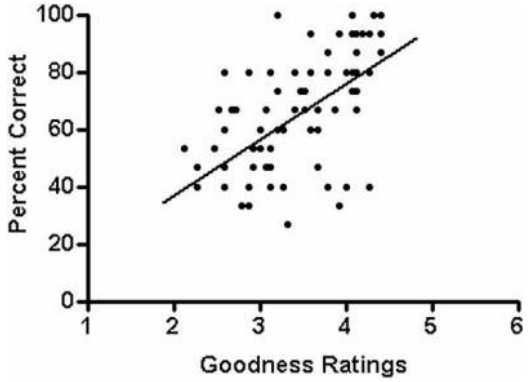

Figure 5 Scatter plot showing the relationship between the percentage of correct responses and the goodness ratings on literal utterances. A significant correlation between ratings on utterances and the correct responses was found.

The relationship between the perception of the intended meaning and the goodness rating on each identified utterance is presented in Figs. 4 and 5. Each point on the scatter plots represents one utterance presented in the single sentence task. Each sentence was plotted with respect to the idiomatic-meaning or literal-meaning goodness ratings on the utterance (*x*-axis) and the percentage of correct responses (*y*-axis) from the randomized single sentence tasks. The graph shows the relationship between ratings on utterances and the percentage of correct responses. A significant correlation between ratings on utterances and the correct responses from the randomized single sentences tasks was found for both idiomatic ($r(78) = 0.521$; $P < 0.001$) and literal utterances ($r(78) = 0.562$; $P < 0.001$), indicating that a higher rating on the given utterance was significantly associated with better identification of the intended meaning of the utterance. That is, the higher the goodness rating on the utterance, the more likely listeners were to identify the intended meaning of the utterance successfully.

Conclusion (Experiment I)

The results revealed that native speakers of Korean successfully discriminated between idiomatic and literal exemplars of Korean ditropic sentences, whether the sentences were presented individually or in pairs. The results from the present study are consistent with the findings from Van Lancker and Canter (1981), Van Lancker Sidtis (2003), and Bélanger *et al.* (2009) in that overall, listeners successfully discriminated between idiomatic and literal utterances, when speakers purposely conveyed the contrasting meanings.

Participants did not successfully discriminate between idiomatic and literal meanings of utterances produced by one of the female speakers (*F*2), also a native Korean citizen as were the other speakers. It was later ascertained that this speaker spent 2 years in the United States between the ages of 2 and 4 years. While idiomatic expressions are not learned early, competence for prosody is acquired very early. It was speculated that the ability to appreciate subtle prosodic contrasts is laid down early in infant language development. A substantial literature has provided evidence that the acquisition of important prosodic parameters starts even before the age of 1 and age 3–5 is critical for the acquisition of syntactic and pragmatic prosody of a language (Allen and Hawkins, 1978, 1980; Crystal, 1979; Katz *et al.*, 1996; Mehler *et al.*, 1998; Pinker, 1994; Speer and Ito, 2008). Thus, based on these findings, the possibility exists that deficient prosodic performance of the female speaker (*F*2) might be the cause for the reduced identifiability of her exemplars bylisteners. These findings are also consistent with post hoc analyses in Van Lancker Sidtis (2003), which revealed that native American listeners who were raised by non-native parents performed significantly worse on the ditropic American English sentence discrimination task than native American English speakers with native American parents (Van Lancker Sidtis, 2003), suggesting that the exposure to prosodic nuances during early development may affect perceptual competence.

There was a significant correlation between the identification of the idiomatic versus literal meanings of utterances and goodness ratings of utterances. The higher the goodness rating on the utterance, the more likely listeners were to identify the intended meanings of utterances. The results suggests that selected auditory features of idiomatic and literal utterances, at least in part, may represent cultural stereotypes of formulaic expressions, and that listeners utilized all or portions of these features consistently and successfully to differentiate between idiomatic and literal utterances. These results suggest that native speakers of a language store and process formulaic versus newly created, novel exemplars and that they do so in accordance with a set of measurable auditory/acoustic cues. It does not follow that these cues are always present in naturalistic conversation, where contextual information can be utilized to disambiguate the sentence meanings.

Experiment II: acoustic study

The primary goal of the acoustic study was to examine the acoustic cues native speakers of Korean use to indicate the intended meaning of ditropic sentences in terms of *F*0, intensity and duration by examining significant contrasts between the utterance types.

Method

For details of the stimuli and the recording procedures, see the Method section of Experiment I.

Data analysis

Acoustic analyses were conducted utilizing PRAAT version 4.5.25 (Boersma and Weenink, 2005). The following acoustic parameters were selected for examining possible differences between idiomatic and literal counterparts based on previous studies: durations, fundamental frequency (*F*0), and intensity. Durational measurements included overall utterance durations, durations of constituent words and syllables, and variability of syllable durations. *F*0 measures focused in means and standard deviations of utterances and local pitch contours in final position. In order to allow for the *F*0 difference between male and female speakers, mean *F*0 values were converted into *z*-scores. The *z*-scores were calculated as the raw values minus the mean of each speaker's literal/idiomatic *F*0 values, and then were divided by standard deviation of each speaker's literal/idiomatic *F*0 values. Intensity measures included means and standard deviations of utterances.

Statistical analysis

Pairwise *t*-tests compared measures for durations, *F*0, and intensity. In addition, ANOVA and Chi-square analysis were performed to verify possible local differences between two sentence types. We considered an alpha level of 0.05 to be statistically significant in all statistical tests.

Results

Figure 6 summarizes means for *F*0, intensity, duration, *F*0 variation, intensity variation, and syllable duration variation for literal and idiomatic sentences across four speakers.

Fundamental frequency (*Fo*)

A pairwise *t*-test revealed no significant differences between literal and idiomatic sentences in either mean *F*0 or standard deviation of *F*0 (SD *F*0). Closer examination of terminal *F*0 changes in individual sentences revealed a consistent pattern: the *F*0 change between last two syllables of literal sentences tended to show falling patterns, whereas the idiomatic sentences tended to have rising ones (Fig. 7).

To verify difference between sentence type and pitch contour at the end of each sentence, a Chi-square analysis was conducted examining the direction of *F*0 change (rise and fall) in association with sentence type (literal and idiomatic). Final syllables were classified as falling if the *F*0 of penultimate syllables

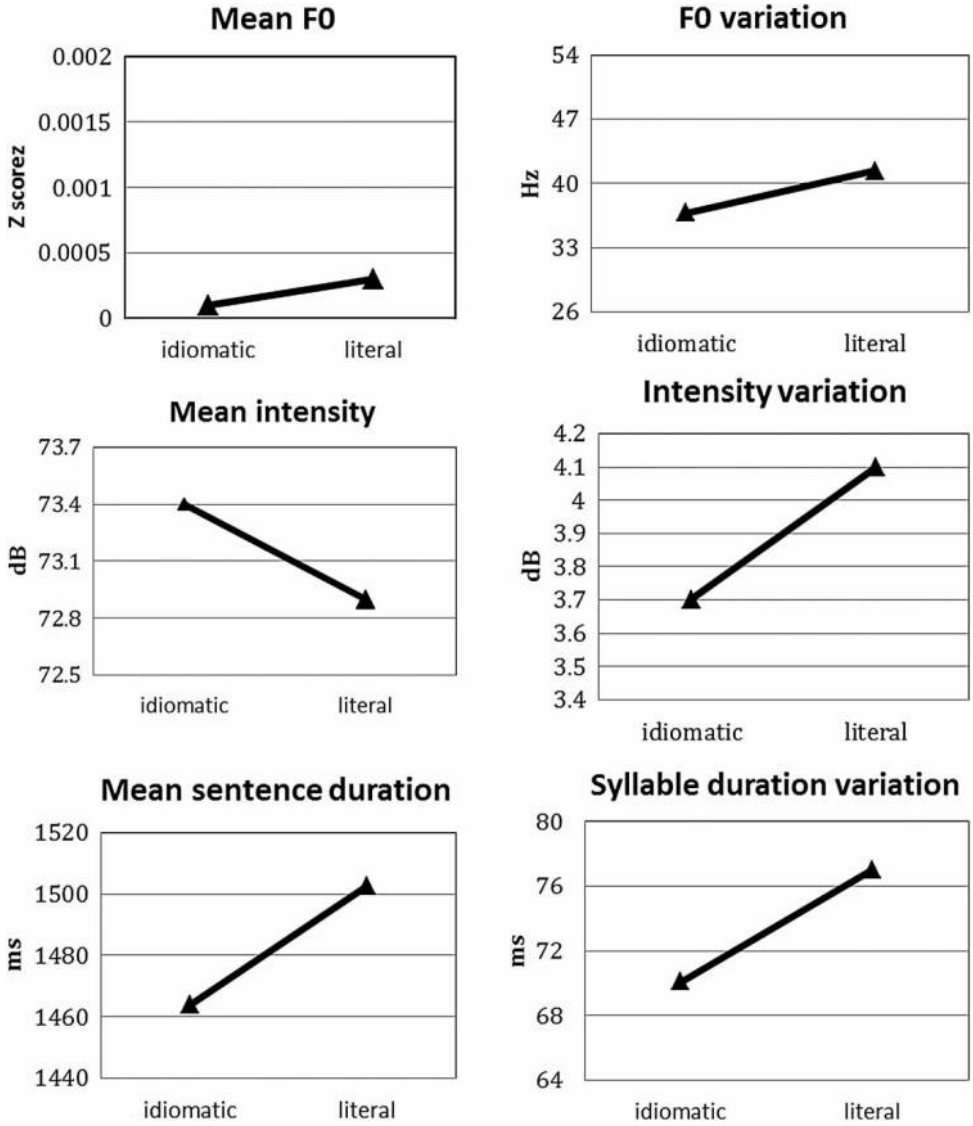

Figure 6 Difference in each acoustic measurement between literal and idiomatic sentences in males, females, and males and females combined (mean intensity, intensity variation, mean sentence duration, and syllable duration variation are significantly different between idiomatic and literal utterances ($P < 0.001$)).

was higher than ultimate syllables of the sentences; final syllables were categorized as rising if the *F*0 of penultimate syllables were lower than ultimate syllables. The result of the Chi-square analysis showed that there was a significant relationship between sentence type and the direction of pitch change: idiomatic sentences more often had rising pitch, and literal sentences more often had falling pitch at end of each sentence (Chi-sq. = 3.947; $P = 0.047$) (Table 1).

Intensity

Mean intensities of idiomatic sentences ($M = 73.4$, SD = 3.6) were significantly greater than those of literal sentences ($M = 72.9$, SD = 3) ($t(79) = -2.157$, $P = 0.034$). Idiomatic sentences ($M = 4.1$, SD = 1.1) were significantly more variable than their literal counterparts ($M = 3.7$, SD = 1.2) ($t(79) = 2.688$, $P = 0.009$). Figure 8 shows the difference in intensity variation between literal and idiomatic sentences across four speakers.

Duration

Literal sentences ($M = 1502.8$, SD = 262) were significantly longer than their idiomatic counterparts ($M = 1463.8$, SD = 268.6) ($t(79) = 2.31$, $P = 0.023$). Literal sentences ($M = 77$, SD = 24.3) showed significantly greater variation in syllable duration within sentences compared to their idiomatic counterparts ($M = 70$, SD = 17.7) ($t(79) = -2.768$, $P = 0.007$). Figure 9 shows the difference in syllable duration difference between literal and idiomatic sentences across four speakers.

Further examination of sentences indicated that the durations of function words (i.e., grammatical particles) and content words differed between two sentence types. A repeated measure ANOVA revealed a significant sentence type *x* content/function word

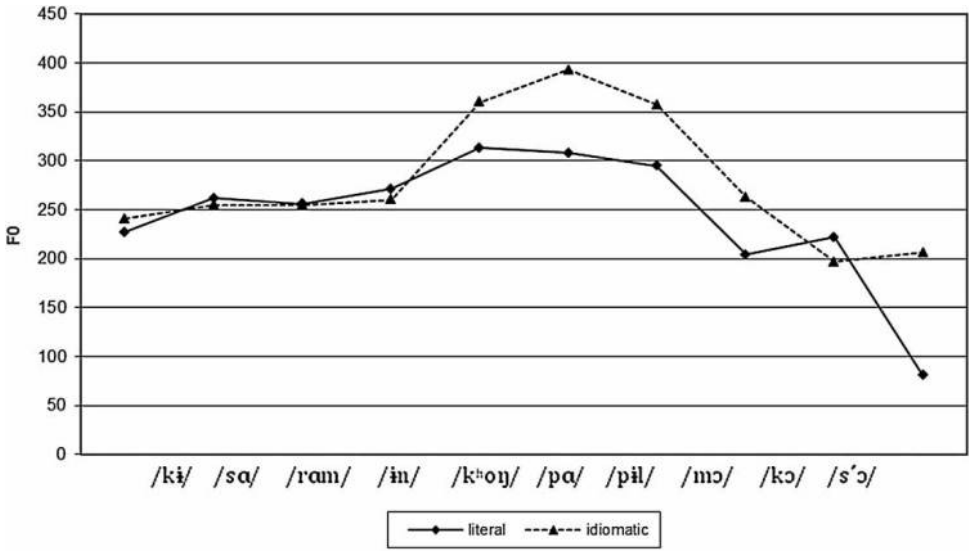

Figure 7 A typical example of fundamental frequency variation within a sentence produced with literal and idiomatic meaning. The sentence (literal: He ate bean-mixed rice, idiom: He served a prison term) was produced by female 1. Note the fundamental frequency change at the end of sentences, literal version of the sentence showing falling fundamental frequency pattern, whereas idiomatic version of the sentence indicating rising fundamental frequency pattern.

interaction ($F(1,79) = 5.558$; $P < 0.001$). Post hoc analyses of durations of function and content words revealed that the durations of function words were significantly shorter in idiomatic sentences compared to literal counterparts ($t(79) = 5.591$, $P < 0.001$), whereas no significant difference was found between the duration of content words in two sentences types. It was also revealed that participants produced longer final syllables in idiomatic utterances compared to literal ($t(79) = -3.309$, $P = 0.001$).

Individual differences

To follow up listeners' lower performance of one of the female speakers (female 2) in Experiment I (the listening study), a further examination of the performance of the individual speakers was carried out. Examination of individual speaker's performance indicated that female 2 failed to produce acoustic contrasts between literal and idiomatic sentences in many measures that were found to be crucial cues to differentiate two types of sentences in other speakers. Percentage of difference between two sentence types in four speakers in each acoustic measure was calculated as follows: |(idiomatic sentence−literal sentence/literal sentence) × 100|.

Table 1 Number of sentences with rising and falling pitch change at the end of literal and idiomatic sentences (Chi-sq. = 3.954; *P* = 0.047)

	Rise	Fall
Literal	22	33
Idiomatic	40	29

Idiomatic sentences more often had rising *F*0 and literal sentences more often had falling *F*0 patterns at the end of each sentence.

In two out of four measures (mean intensity and syllable duration variation), the percentage of difference of female 2 ranked the lowest among the four speakers, and in the remaining two measures (intensity variation and mean sentence duration), she ranked second to the lowest.

Conclusion (Experiment II)

This study revealed that sentence types spoken with contrasting idiomatic or literal meanings differ significantly in several acoustic parameters. Mean intensity, SD intensity, sentence duration, and syllable duration variation significantly differentiated sentences as either literal or idiomatic in Korean. These results differ from those reported for American English and Parisian French. This may arise from the fact that in the Korean language, fundamental frequency is less appropriated as a tool of grammatical contrast, leaving intensity contrasts to serve as a source of differentiating types of phrasal and grammatical meaning. Korean idiomatic sentences were produced with shorter overall durations and higher intensity, greater intensity variation, and greater syllable duration variation compared to literal sentences. For local differences, literal and idiomatic sentences differ with respect to *F*0 contours in the last two syllables of sentences. Idiomatic sentences significantly more often had rising intonation, while their literal counterparts more often showed falling intonation at the end of sentences. Also, idiomatic sentences were characterized by significantly shorter function words and longer final syllables compared to their literal counterparts.

It can be inferred that native speakers of Korean use at least some of these acoustic cues to signal and recognize the contrastive meanings of these two language

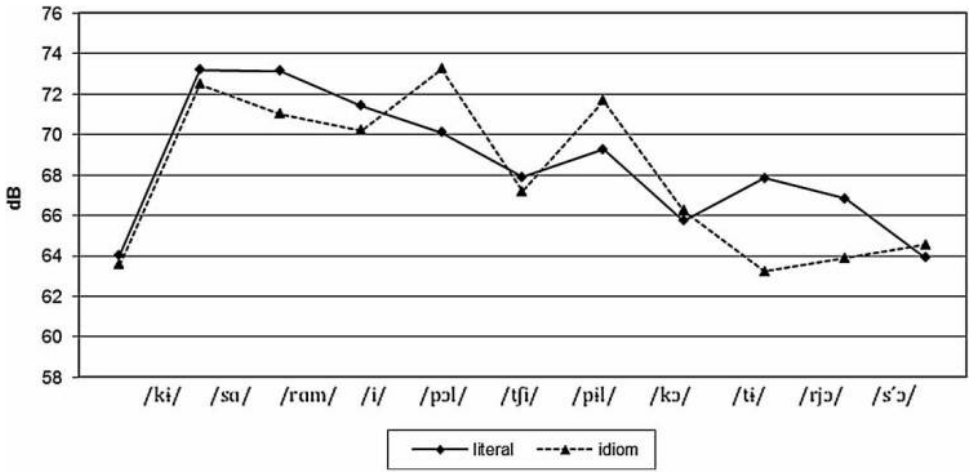

Figure 8 A typical example of intensity variation within a sentence produced with literal and idiomatic meaning. The sentence (literal: He stirred up a beehive, idiomatic: He caused a big problem) was produced by female 1. Note that idiomatic version of the sentence is more variable than literal version of the sentence.

categories. It is possible that additional acoustic cues not measured here, such as voice quality, contribute to differentiating the two types of meanings, as was reported previously for American English (Van Lancker *et al.*, 1981).

The results of this study are consistent with the findings of previous studies from Van Lancker *et al.* (1981), Bélanger *et al.* (2009), and Abdelli-Beruh *et al.* (2007) who found that there are distinctive auditory–acoustic characteristics distinguishing literal and idiomatic utterances. A key question in the current study addressed differences between languages in distinguishing literal from idiomatic meanings. From studies to date, it can be seen that speakers differ in the types of acoustic cues they employ, or if they use the same acoustic cues, they use them in a different manner. For example, *F*0 variation did not contribute to signal the difference between the two types of meanings in Korean, which differs from the previous findings with English and French speakers who consistently used this cue. Unlike *F*0 variation, intensity variation did show differences in two sentence types in Korean (intensity was not measured in English or French exemplars). Furthermore, although all Korean, English, and French speakers utilized duration cues to disambiguate between idiomatic and literal meanings, they employed this parameter in a different manner: whereas literal utterances were longer than idiomatic sentences in Korean and English speakers (Van Lancker *et al.*, 1981), French speakers showed the opposite pattern. Also, Korean speakers produced idiomatic and literal sentences with rising and falling intonation, respectively, while English speakers showed abrupt pitch change, either up or downward, in the idiomatic but not in the literal sentences. The finding of longer final syllables

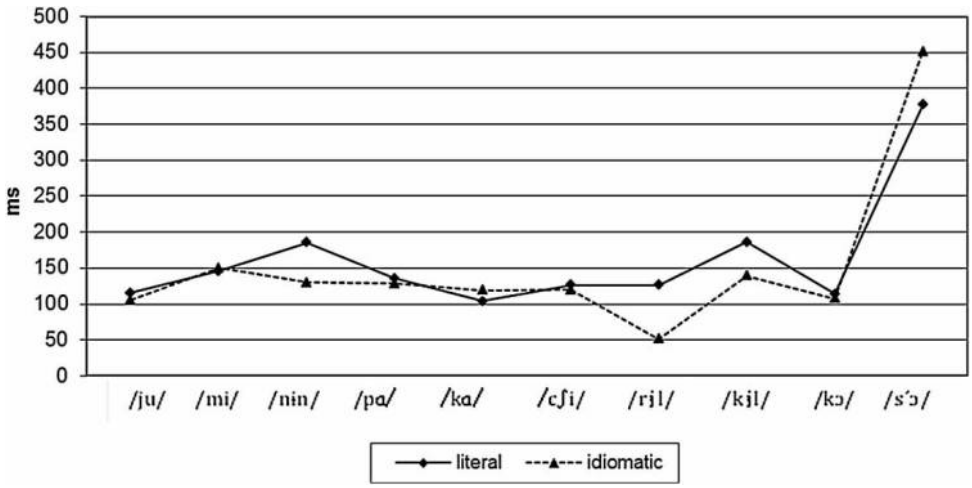

Figure 9 A typical example of syllable duration variation within a sentence produced with literal and idiomatic meaning (duration in milliseconds is on the *y*-axis). The sentence (literal: Scratched a gourd, idiom: Nagged) was produced by male 2. The function word (/nɨn/, /rɨl/) is shorter and the final syllable (/śɔ/) is longer in the idiomatic version of the sentence than in the literal version of the sentence.

in idiomatic sentences compared to their literal counterparts is in agreement with Bélanger *et al.* (2009). In contrast, the duration of function words, but not content words, differed in two sentence types in Korean. In both Van Lancker *et al.* (1981) and Belanger *et al.* (2009), content words in English appeared to carry the duration differences between two sentence types.

As might be expected, some of the acoustic cues that characterize idiomatic sentences in this study reflect certain properties of idiomatic expressions in Korean. For instance, shorter duration of function words in idiomatic sentences compared to their literal counterparts gives less emphasis to grammatical elements, supporting the idea that idioms are stored and processed as a single lexical unit. Function words that were used in the current study were all case particles that were attached to nouns. Korean case particles can be omitted without changing the meaning of the sentence, and this commonly happens in informal oral speech (Iksop Lee and Ramsey, 2001). No speaker had omitted any particles in the target sentences, but they appear to reduce the duration of the function words to signal the contrast. The shorter case particles suggest that grammatical relations between words lost or minimized their function in the idiomatic version of sentences. Shorter duration of function words in idiomatic sentences compared to their literal counterparts may provide evidence for holistic processing of idiomatic sentences. Idiomatic sentences are holistically processed without analyzing the subcomponents, which may result faster rate and in shorter duration of function words. The concept behind the notion of a 'fixed expression' is that the individual lexical elements are not separately retrieved, but belong in a holistic configuration as, some have said, a phonological unit (e.g., Lin, 2010). The observation of shorter function words is compatible with this viewpoint.

The findings also yielded individual differences. It was apparent that female 2 did not produce measurable contrasts in some key acoustic measures. This is interesting since in Experiment I (the perception study), sentences produced by female 2 were the most poorly identified.

General discussion

One purpose of this study was to determine whether native speakers of Korean could consistently distinguish intended meaning of ditropic sentences, as has been found for American English and Parisian French. A second purpose was to compare results from an Asian language with these reported for two Indo-European languages. The other question concerned what kinds of auditory–acoustic information Korean speakers produce to allow listeners to determine whether the intended meaning of a ditropic sentence is literal or idiomatic, and how these are similar to or different from previously reported acoustic parameters.

Taken together, the results indicated that idiomatic utterances, as examples of formulaic language, and literal utterances, as examples of newly created, novel language, are differentiated in production and perception in native speakers of Korean. The findings showed that speakers consistently produced discernable prosodic patterns for each type of sentence. The consistency of their choice of prosodic cues was sufficient to allow listeners to discern the intended meanings. It can be inferred that these prosodic contrasts form part of the native speaker's competence. Differences between the two kinds of language, idiomatic and literal, are signaled by quantifiable acoustic cues in Korean, and native listeners of Korean can reliably discriminate between them. Listeners demonstrated better performance in identifying the intended meanings of utterances with higher goodness ratings, which further underscores the status of these two sentence types in native competence.

A previous research study (Van Lancker and Canter, 1981) showed that speakers did not contrast the meanings with prosodic cues in spontaneous conversation since contextual cues were available to be utilized. This observation parallels results found for sarcasm and irony. When asked to produce utterances with either a sarcastic or a neutral meaning, native speakers of a language produce consistent, discernible cues, which listeners can recognize about 80–90% of the time (well above chance, since 'chance' would be 50%). But in running conversation, these cues may not appear in this same form, as context is potent in revealing the speaker's meaning. It may be said that there are stereotyped prosodic profiles for literal versus idiomatic sentence types. We can conclude that speakers of a language know these things, not that they always 'use' them in naturalistic verbal communication.

The finding, now reported in a third (non-Indo-European) language, suggests that distinctive mental representation of literal and idiomatic utterances may exist and that acoustic cues contribute to differentiate these two forms of language. As literal and idiomatic utterances are typical examples of literal and formulaic expressions, respectively, current findings support the notion that literal and formulaic language forms two separate categories, which are likely to be part of the speaker's grammatical competence, and provide further insights into underlying language processing mechanisms associated with the two distinctive language categories. The results also support the notion that formulaic expressions are characterized by stereotyped form, which includes prosodic

properties (Van Lancker Sidtis, 2006). Evidence for phonological form has been attributed to formulaic expressions (Erman, 2007; Lin, 2010). Further evidence for unique prosodic shapes on formulaic expressions arose from a study of Swedish proverb production, compared with matched literal expressions, in adults and children (Hallin and Van Lancker Sidtis, in press). Speakers may store and process these forms in idealized or canonical versions, which can be referred to as a 'formulemes' (Van Lancker Sidtis, 2008), 'superlemmas' (Kuiper *et al.*, 2007), or lexicalized long words, leading to the lexical representation hypothesis for formulaic expressions (Berman and Ravid, 2010; Swinney and Cutler, 1979).

These results, supporting native speakers' identification of formulaic utterances based on acoustic presentation alone, have important implications for the role of memory and learning in linguistic competence. For memory, knowledge of this very large repertory of canonical forms, together with their myriad phonetic, prosodic, semantic, and pragmatic properties, implies a prodigious, episodic storage function in association with language competence. With respect to learning, formulaic expressions, based on the unique characteristics that distinguish them from literal expressions, may be acquired more in the way of one-trial than in incremental learning (Reuterskiöld and Van Lancker Sidtis, 2012).

While the results of this study contribute to our understanding of production differences between idiomatic and literal utterances and native listeners' ability to identify them, it is acknowledged that the generalization of these findings is limited to the types of idioms and the acoustic features that were measured in this study. Ditropic sentences utilized as stimuli in this study were not analyzed in terms of their information-bearing characteristics, such as meaningfulness and semantic connotations. Some studies reported that semantic compositionality of idioms may influence idiom processing (Gibbs and Nayak, 1989; Gibbs *et al.*, 1989; Tabossi *et al.*, 2008). Another issue regarding the validity of results is the sample size, having four speakers produce stimuli. The need for replication of the study with larger number of speakers is therefore acknowledged. Future research should question whether other aspects of prosody, such as rate, rhythm, resonance, spectral characteristics, vowel space, and voice quality, also contribute to signal the difference between the two types of utterances. Further studies regarding the prosodic and overall auditory–acoustic features of other types of formulaic expressions, and further information about cerebral processing of these features, will enhance our understanding of this important aspect of language.

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Disclaimer statements

Contributors All authors listed have contributed sufficiently to the project to be included as authors, and all those who are qualified to be authors are listed in the author byline.

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Appendix 1: List of Korean ditropic sentences

Korean ditropic sentences	English interpretations	
	Literal	Idiomatic
1 오늘은 다리를 뻗고 자겠네. (/oni̞ri̞ntari̞ri̞lp'ɔkocʃakene/)	I am going to sleep with my legs stretched today	I can live my life with a clean conscience today
2 우리 일행은 발이 묶였어. (/uriilhæŋi̞npɑli̞lmuk'jɔs'ɔ/)	Our legs were tied	We were stranded without transport
3 그 사람은 콩밥을 먹었어. (/ki̞saɾɑmi̞nk^{h}oŋpɑpi̞lmɔkɔ́sɔ/)	He ate bean-mixed rice	He served a prison term
4 윤호가 유미의 가려운 데를 긁어줬어. (/junhokɑjumii̞kaɾjɔunteri̞lki̞lkɔcʃuɔs'ɔ/)	Yoonho scratched Yumi's itchy spot	Yoonho explained something to Yumi so perfectly that there was nothing left to be desired
5 그 사람이 벌집을 건드렸어. (/ki̞saɾɑmipɔltʃipi̞lkɔti̞rjɔs'ɔ/)	He stirred up a beehive	He caused a big problem
6 윤호는 배가 아팠어. (/junhoni̞npækɑapɑs'ɔ/)	Yoonho had a stomach ache	Yoonho was jealous
7 내가 칼자루를 쥐고 있어. (/næk^{h}ɑkɑlcʃɑruri̞lʃi̞koiśɔ/)	I am holding a sword by the hilt	I am in charge
8 그 아이는 발을 굴렀어. (/ki̞ɑini̞npɑli̞lkulrɔs'ɔ/)	The kid stamped his feet	The kid was nervous
9 유미가 바가지를 긁었어. (/jumigɑpɑkɑcʃiri̞lki̞lkɔs'ɔ/)	Yumi scratched a gourd	Yumi nagged
10 윤호는 벼랑끝에 매달렸어. (/junhoni̞npjɔraŋk'i̞temætɑlrjɔs'ɔ/)	Yoonho barely hung by the cliff	Yoonho was in a desperate situation

University and participants signed a written consent form approved by the IRB.

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